# User's Manual

## SDEN

Version 1.9.0

## Chemical software
## Single/multi stage distillation simulator

Windows XP® - Windows Vista® - Windows 7® - Windows 8® - Windows 10®

VAXA SOFTWARE

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## Introduction

SDEN is a single/multi-stage binary distillation simulator for Windows using Rayleigh equation. SDEN can simulate distillations from 1 to 6 consecutive stages.

This manual isn't about single/multi-stage binary distillation theories.

Please, read this manual carefully in order to learn all the capabilities of the application.

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## Main window: *Main* panel

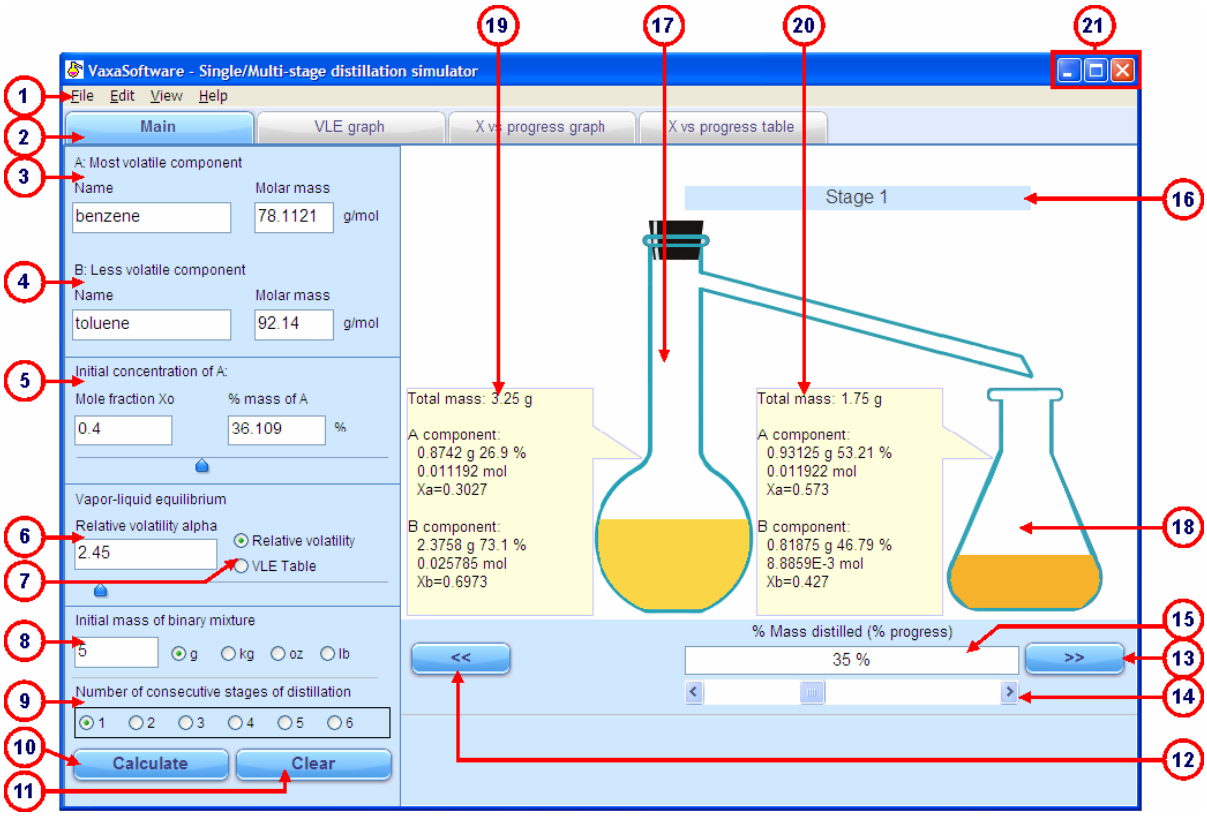


**Fig. 1**
Main window: *Main* panel

### (1) Menu bar

It contains the menus *File*, *Edit, View* and *Help*.

***File*** menu

***Calculate***
Calculates output values from input values.

***Open...***
Allows us to open a Binary Distillation File (*.bdf).

***Save***
Saves the current distillation data as a Binary Distillation File (*.bdf).

***Save as...***
Asks us for a filename and saves the current data as a Binary Distillation File (*.bdf).

***Print...***
Open the *Print* window to print one of the following items (when it's visible):
- VLE graph (Vapor-Liquid Equilibrium graph).
- X vs Progress graph

***Exit***
Close the application.

***Edit*** menu

***Copy***
Copies either *ELV-graph* or *X vs Progress graph* or *X vs Progress table* to the clipboard.

***View*** menu

***Main***
Shows the *Main* panel.

***ELV* graph**
Shows the VLE graph  (Vapor-Liquid Equilibrium graph).

***X vs Progress* graph**
Shows the X vs Progress graph (X parameter vs distillation progress).

***X vs Progress* table**
Shows the X vs Progress table (X parameter vs distillation progress).

***Liquid color***
Allows us to select the color of the simulated liquid.

***Help*** menu

***User's manual (PDF document)...***
Shows this manual.

***Application registration...***
Shows the registration form window to register the application.

***Disabled functions in the unregistered version***
Shows the list of disabled functions when the application is not registered.

***Home page (www.vaxasoftware.com)...***
Connects to VaxaSoftware home page.
An active Internet connection and a browser are required.

***About...***
Shows the *Splash* window with the version and description of the application.

## (2) Tab bar

It contains the following tabs:

***Main*** tab
Shows the *Main* panel.

***ELV* graph** tab
Shows the *VLE* graph (Vapor-Liquid Equilibrium graph).

***X vs Progress* graph** tab
Shows the *X vs Progress* graph (X parameter vs distillation progress).

***X vs Progress* table** tab
Shows the *X vs Progress* table (X parameter vs distillation progress).

### (3) Name and molar mass of the most volatile component (A)

Allows us to enter the name and the molar mass of the most volatile component of the binary mixture.
The most volatile component is denoted as "A".

### (4) Name and molar mass of the less volatile component (B)

Allows us to enter the name and the molar mass of the less volatile component of the binary mixture.
The less volatile component is denoted as "B".

### (5) Initial composition of "A" component (most volatile component)

Allows us to enter the initial mole fraction or initial percentage by mass of "A" component.

◆ ***Note 1:***
***Decimal separator:***
We can use either point [ . ] or comma [ , ] as decimal separator.

◆ ***Note 2:***
***Scientific notation:***
The scientific notation is used to show very big or very small numbers. A scientific notation number has a mantissa and a power of 10.
To enter a scientific notation number we use letter E to input the exponent of 10.

Examples:
$5.67 \times 10^{89}$ is entered as 5.67 E 89
$1.23 \times 10^{-34}$ is entered as 1.23 E-34

### (6) Relative volatility

Allows us to enter the relative volatility $\alpha$ (alpha).

### (7) Vapor-liquid equilibrium

Allows us to select the following method for vapor-liquid equilibrium (VLE):

*Relative volatility.*
Use this option if the vapor-liquid equilibrium has a constant relative volatility.

*Table.*
Use this option if the vapor-liquid equilibrium has a variable relative volatility and/or there is azeotrope.
Click the *Edit table* button to edit the Vapor-Liquid Equilibrium table.

### (8) Initial mass of binary mixture.

Allows us to enter the mass of binary mixture for the first distillation stage.
We can select one of the following mass units:
g (gram), kg (kilogram), oz (ounce), lb (pound)

### (9) Number of consecutive stages of distillation

Allows us to select the number of stages of distillation.
We can select between 1 and 6 stages.

### (10) *Calculate* button

Calculates output values from input values.

### (11) *Clear* button

Clears all the input/output values.

### (12) (13) Scroll buttons

Allows us to select each stage of distillation.

### (14) Percentage of distillation progress scroll bar

Allows us to set the percentage of progress for the current stage of distillation.

### (15) Percentage of distillation progress textbox

Shows us the percentage of progress for the current stage of distillation and allows us to set it.

### (16) Number of the current distillation stage

Shows us the number of the current distillation stage.

### (17) Still pot

Shows us a simulation of liquid in the still pot.

### (18) Distillate flask

Shows us a simulation of liquid in the distillate flask.

### (19) Information about liquid in the still pot

Shows us the following data about the liquid in the still pot:

Total mass

Mass of most volatile component "A"
- Percentage by mass of "A"
- Moles of "A"
- Mole fraction of "A"

Mass of less volatile component "B"
- Percentage by mass of "B"
- Moles of "B"
- Mole fraction of "B"

### (20) Information about liquid in the distillate flask

Shows us the following data about the liquid in the distillate flask:

Total mass

Mass of most volatile component "A"
- Percentage by mass of "A"
- Moles of "A"
- Mole fraction of "A"

Mass of less volatile component "B"
- Percentage by mass of "B"
- Moles of "B"
- Mole fraction of "B"

### (21) Window control buttons

These are the classic buttons of the windows of MS-Windows ®.

***Minimize*** button
Minimizes the application to an icon on the desktop.

***Maximize / Restore*** button
Maximizes / restores the application's window size.

***Close*** button
Closes the application. Also we can press Alt + F4 keys on our keyboard.

## Main window: *VLE* graph

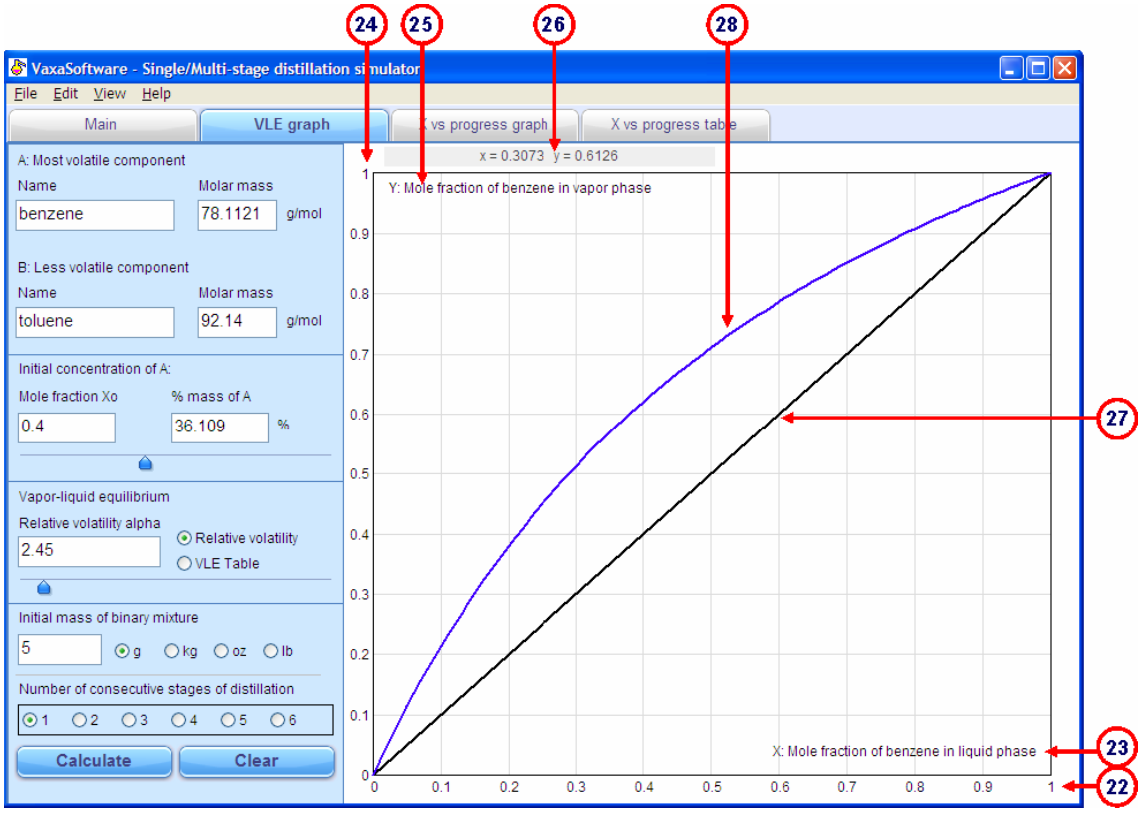


**Fig. 2**
Main window: *VLE* graph

### (22) Scale of values of X-axis

Shows the scale of values of X-axis.

### (23) X-axis title

Shows the X-axis title.

### (24) Scale of values of Y-axis

Shows the scale of values of Y-axis.

### (25) Y-axis title

Shows the Y-axis title.

### (26) Mouse coordinates

Shows (x, y) coordinates of the mouse.

### (27) y = x line

Shows the y = x line.

### (28) VLE curve: Vapor-liquid equilibrium curve

Shows the VLE (Vapor-Liquid Equilibrium) curve.

- We can modify the curve with the mouse when using constant relative volatility. The relative volatility is changed while we move the curve.

- If we use a table of VLE we can double click on the curve to edit the VLE table

## Main window: *X vs Progress* graph

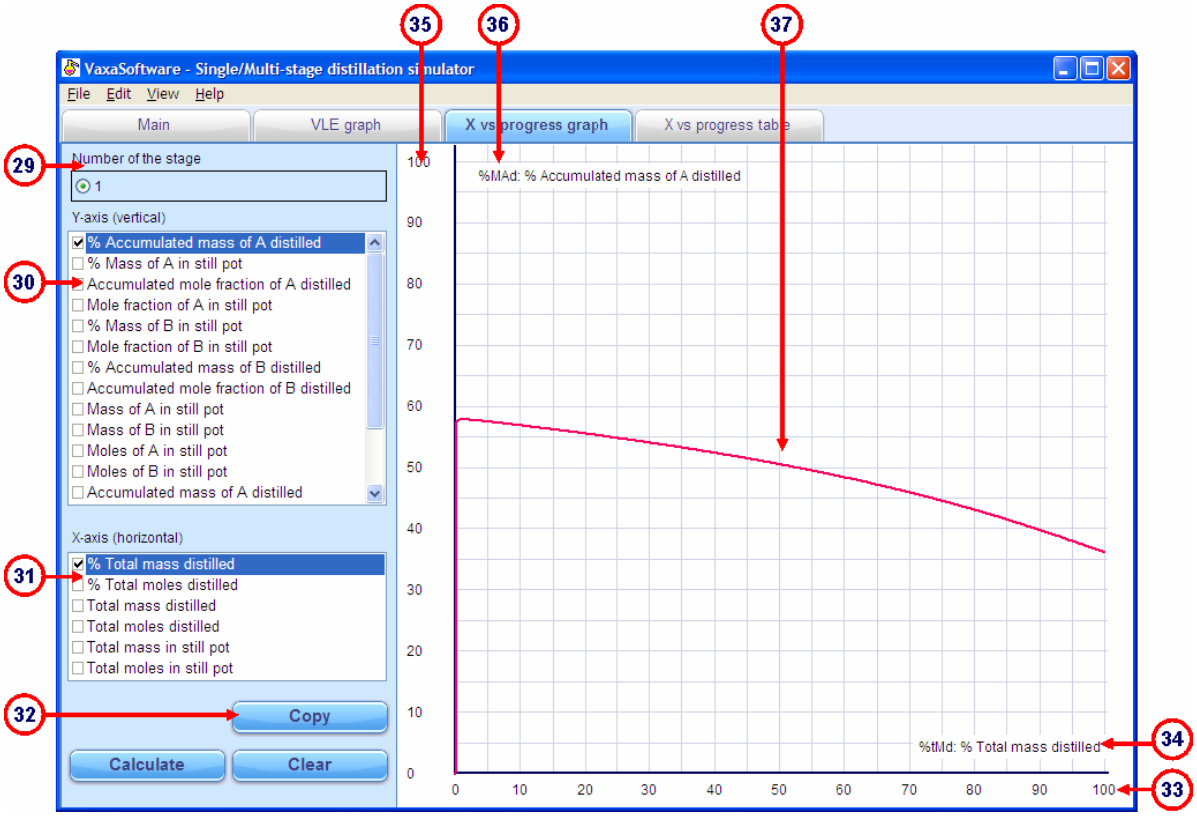


**Fig. 3**
Main window: *X vs Progress* graph

### (29) Number of the current distillation stage

Allows us to select the current distillation stage.

### (30) Y-axis parameters

Allows us to select one of the following Y-axis parameters.

- % Accumulated mass of A distilled
- % Mass of A in still pot
- Accumulated mole fraction of A distilled
- Mole fraction of A in still pot
- % Mass of B in still pot
- Mole fraction of B in still pot
- % Accumulated mass of B distilled
- Accumulated mole fraction of B distilled
- Mass of A in still pot
- Mass of B in still pot
- Moles of A in still pot
- Moles of B in still pot
- Accumulated mass of A distilled
- Accumulated mass of B distilled
- Accumulated moles of A distilled
- Accumulated moles of B distilled
- Mole fraction of A in distilled vapor

### (31) X-axis parameters

Allows us to select one of the following X-axis parameters.

- % Total mass distilled
- % Total moles distilled
- Total mass distilled
- Total moles distilled
- Total mass in still pot
- Total moles in still pot

### (32) Copy button

Copy the graph to the clipboard.

### (33) Scale of values of X-axis

Shows the scale of values of X-axis.

### (34) X-axis title

Shows the X-axis title.

### (35) Scale of values of Y-axis

Shows the scale of values of Y-axis.

### (36) Y-axis title

Shows the Y-axis title.

### (37) Curve

Shows the curve of Y-axis parameter vs X-axis parameter.

## Main window: *X vs Progress* table

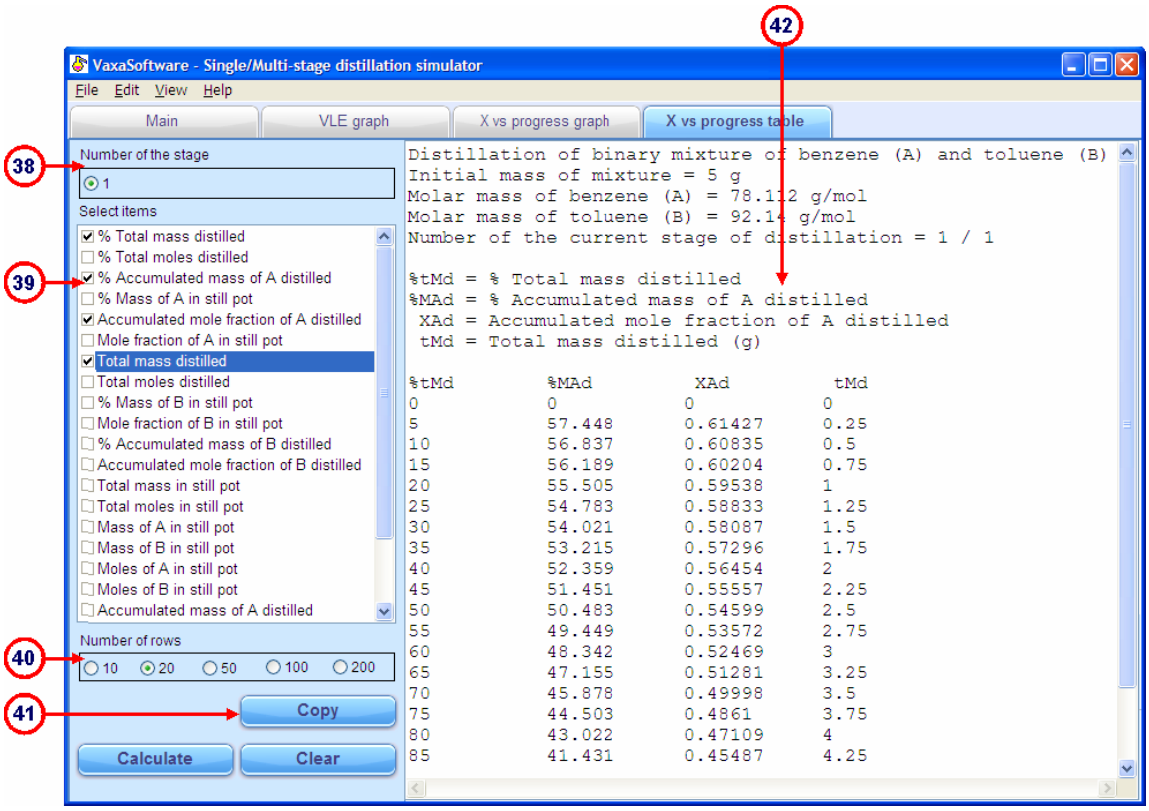
42
VaxaSoftware - Single/Multi-stage distillation simulator
File Edit View Help
Main
VLE graph
X vs progress graph
X vs progress table
38
Number of the stage
1
Select items
39
% Total mass distilled
% Total moles distilled
% Accumulated mass of A distilled
% Mass of A in still pot
Accumulated mole fraction of A distilled
Mole fraction of A in still pot
Total mass distilled
Total moles distilled
% Mass of B in still pot
Mole fraction of B in still pot
% Accumulated mass of B distilled
Accumulated mole fraction of B distilled
Total mass in still pot
Total moles in still pot
Mass of A in still pot
Mass of B in still pot
Moles of A in still pot
Moles of B in still pot
Accumulated mass of A distilled
40
Number of rows
10 20 50 100 200
41
Copy
Calculate
Clear
Distillation of binary mixture of benzene (A) and toluene (B)
Initial mass of mixture = 5 g
Molar mass of benzene (A) = 78.112 g/mol
Molar mass of toluene (B) = 92.14 g/mol
Number of the current stage of distillation = 1 / 1
%tMd = % Total mass distilled
%MAd = % Accumulated mass of A distilled
XAd = Accumulated mole fraction of A distilled
tMd = Total mass distilled (g)
%tMd %MAd XAd tMd
0 0 0 0
5 57.448 0.61427 0.25
10 56.837 0.60835 0.5
15 56.189 0.60204 0.75
20 55.505 0.59538 1
25 54.783 0.58833 1.25
30 54.021 0.58087 1.5
35 53.215 0.57296 1.75
40 52.359 0.56454 2
45 51.451 0.55557 2.25
50 50.483 0.54599 2.5
55 49.449 0.53572 2.75
60 48.342 0.52469 3
65 47.155 0.51281 3.25
70 45.878 0.49998 3.5
75 44.503 0.4861 3.75
80 43.022 0.47109 4
85 41.431 0.45487 4.25

**Fig. 4**
Main window: *X vs Progress* table

### (38) Number of the current distillation stage

Allows us to select the current distillation stage.

### (39) Parameters

Allows us to select one of the following parameters.

% Total mass distilled
% Total moles distilled
% Accumulated mass of A distilled
% Mass of A in still pot
Accumulated mole fraction of A distilled
Mole fraction of A in still pot
Total mass distilled
Total moles distilled
% Mass of B in still pot
Mole fraction of B in still pot
% Accumulated mass of B distilled
Accumulated mole fraction of B distilled
Total mass in still pot
Total moles in still pot
Mass of A in still pot
Mass of B in still pot
Moles of A in still pot
Moles of B in still pot
Accumulated mass of A distilled
Accumulated mass of B distilled
Accumulated moles of A distilled
Accumulated moles of B distilled
Mole fraction of A in distilled vapor

### (40) Numbers of rows

Allows us to select the numbers of rows in the table.

### (41) Copy button

Copy the table to the clipboard.

### (42) Table

Shows us the table.

## Window: *VLE: Vapor-Liquid Equilibrium table*

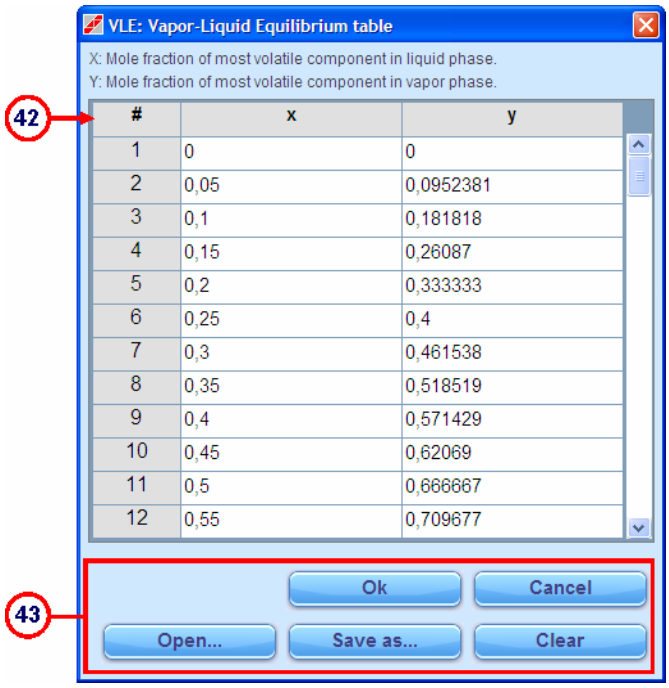


**Fig. 5**
Window *VLE: Vapor-Liquid Equilibrium table*

### (42) Data table

Allows us to enter the values of X and Y of a VLE (Vapor-Liquid Equilibrium).
X is the mole fraction of most volatile component "A" in liquid phase.
Y is the mole fraction of most volatile component "A" in equilibrium in vapor phase.

### (43) Buttons

***Ok*** button
Checks the table, closes the dialog window and returns to the main window. The edited data table will be used.

***Cancel*** button
Closes the window. The edited data is not used.

***Open...*** button
Allows us to open a file of table (*.vle) or import a Binary Distillation File (*.BDF)

***Save as...*** button
Asks us for a filename and saves the current table as a file (*.vle).

***Clear*** button
Clears the table.

## Example

We want to make a double distillation of 2500 g of ethanol-water solution of 15% ethanol by mass. In the first stage we distillate 1000 g (40% of the initial solution). In the second stage we distillate 600 g (60%). Find out the concentration of ethanol in the second distillate solution.

**Procedure:**

1) Set the number of distillation stages as 2.

2) Select *Table* in Vapor-Liquid Equilibrium section.

3) Press *Edit table...* button to open the *VLE* window.

4) Press *Open* button to open the table *Ethanol-water.vle* that is in *Example* subfolder located in the directory where the application was installed.

5) Press *OK* button to close the window and return to main window.

6) In the main window we enter the following data:

| | |
|---|---|
| % mass of A | 15 |
| Initial mass of binary mixture | 2500 g |
| Number of stages | 2 |

7) We enter the percentage progress of each stage (% of distillate mass).

| | |
|---|---|
| Stage 1 | 40 % |
| Stage 2 | 60 % |

8) Finally we get the following results for the second stage in the distillate flask.

| | |
|---|---|
| Total mass: | 600 g |
| | |
| "A" component: | |
| Mass; | 358.48 g |
| % mass | 59.75 % |
| Moles | 7.7811 mol |
| Mole fraction of A | Xa = 0.3672 |

## Shortcut keys

***Main*** window

| | |
|---|---|
| **F5** | Calculate |
| **Ctrl + O** | Open... |
| **Ctrl + S** | Save |
| **Ctrl + P** | Print... |
| **Ctrl + F4** | Exit |
| **Alt + F4** | Exit |
| **Ctrl + C** | Copy |
| **Page Up** | Show the next distillation stage |
| **Page Down** | Show the previous distillation stage |
| **F1** | Help: Show User's Manual (PDF document...) |
| **Mayús+F1** | About... |

## Specifications

| | |
|---|---|
| **Description** | ***SDEN*** is a single/multi-stage distillation simulator for Windows using Rayleigh equation. |
| **License** | Trialware |
| **Unregistered version restrictions** | Initial mole fraction of A is locked. |
| **Decimal separator** | Point or comma. |
| **Thousands separator** | You may use spaces to separate the thousands. However, the output results are displayed without a separator. |
| **Binary mixture distillation file extension:** | *.BDF |
| **VLE (Vapor-Liquid Equilibrium) data input** | - Relative volatility.<br>- Table of VLE (or files *.vle / *.bdf). |
| **Azeotrope support** | Yes |
| **Maximum number of consecutive stages** | 6 |
| **Maximum number of parameters in the *X vs Progress* table** | 23 parameters |
| **Number of X-axis parameters for the *X vs Progress* graph** | 17 parameters |
| **Number of Y-axis parameters for the *X vs Progress* graph** | 6 parameters |
| **Number of colors for the liquid simulation** | 5 colors |

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